though large working models show the feasibility of not only running trains upon such a track by any of the motive powers mentioned, but also of running them safely around short curves and at high speeds.

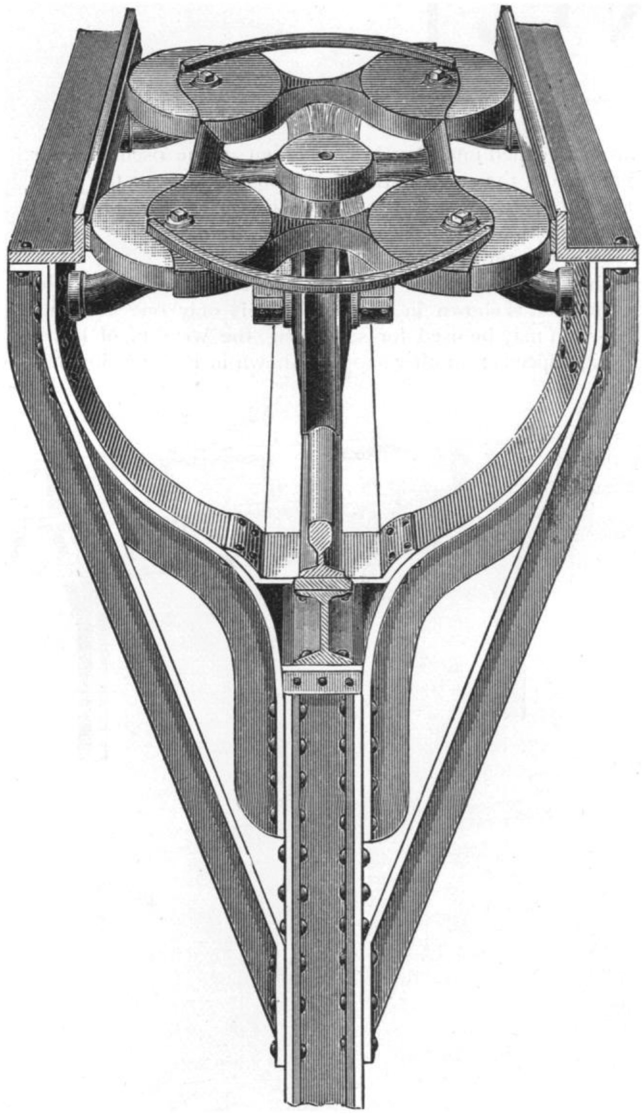

FIG. 2. — THE GUIDE-WHEELS OF THE WHITE RAILROAD.

ELECTRICAL NEWS.

Light without Heat.

PROFESSOR BRACKETT of Princeton College delivered an interesting address before the New York Electric Club some weeks ago. The part of his lecture which treated of the production of light without heat gave an admirable summary of Dr. Hertz's experiments on electro-magnetic waves, and afterwards Professor Brackett indicated the lines on which he thought it would be best to experiment to obtain practical results. Briefly the state of the case is this: light consists of electro-magnetic vibrations of a definite and very short period. In our ordinary methods of artificial illumination we produce vibrations of a period that will affect the eye, by heating particles to incandescence, the resultant vibrations being of a great number of periods, only a few of them being of use for illumination. In fact, a great deal of energy is wasted, only a very small proportion of the total appearing in a form that is useful to us. Now, the problem that is presented is to produce vibrations of the period we want, and no other; and the problem is a very difficult one to solve. In nature there are phosphorescent substances and certain insects — glow-worms, fire-flies, etc. — which are very efficient illuminants, the light produced being accompanied by very little heat: so the problem is not impossible, and we may regard it hopefully. The most serious difficulty lies in the extreme rapidity of the oscillations required, billions of them a second, — a rapidity so great that it seems impossible to attain it by any mechanical means. Nor would it be possible to economically distribute the vibrations when they were produced.

Professor Brackett proposes to solve the problem by working it backwards, to take a beam of light, polarize it so that all of its vibrations are in one plane, and "harness that to a wire, so that it will make a current vibrate and also make the magnetic field about the wire vibrate: in other words, if you cannot do the sum, take the answer and work backwards. That is what I intend to do, and I will hint to you exactly how I propose to do it. It cannot be done with the ordinary materials employed for conductors, if it has to heat the wire. . . . We must get something that is not a conductor in the ordinary sense. I remind you that the amount of energy expended in the movement in the high vacuum tube, in the ordinary tube, where you have the most beautiful illuminations, is, in matter of fact, very small. . . . I point out to you next that there is one substance in which we have the properties of both the conductor and the non-conductor present, and there are some very hopeful indications in that. A selenium cell, which is semi-transparent, when it is joined up and a battery current is put through it, is found to have its resistance diminished immediately a flash of light falls on it. . . . Suppose we take a polarizing apparatus by which we can polarize a long web of light. It will consist of vibrations all sorted out in parallel planes by themselves. . . . Now let this polarized web of light be passed through a narrow slit so as to pass directly upon or near the conductor in which we wish to set up an alternating electric current. If the proper conductor can be found, it should have the current set up in it, and this should produce a magnetic field about it. . . . What we want is an alternating current or discharge of some sort or other, which shall enable us to produce the alternations with such frequency that the so-called conductors will break out and shine directly. . . . A dynamometer ought to be constructed which would be capable of measuring the effect. But with the ordinary opaque conductor, such frequency means confusion among the molecules, which brings about a difficulty. That is what we must get rid of."

In a subject like this, which is certain to command the attention of investigators and inventors, which gives so much promise, and in which there seems no impossibility, it is well to keep abreast of even the suggested solutions. Professor Brackett's plan seems to be to transmit light from places where the sun is shining, to other places where it is not. But it is hard to see how this plan can work successfully. Vibrations of such rapidity as those of light-waves cannot be transmitted along a conductor, for conductors would offer a practically infinite resistance to currents of such a period. They are transmitted through a dielectric simply as light; and the fact that we believe light to be an electro-magnetic disturbance does not help us to solve the problem. The transmission of light as such stands just where it did before Hertz's experiments or Maxwell's theory were published. The efficiency of transmission of the waves, however they are transmitted, is much greater as the period is increased. A wave of a period some millions of times less than that of light might be transmitted from China here without much loss, provided we did it properly, while the energy of a light-wave would be dissipated before it had gone a mile. If we wish to transmit light, we must reduce the vibrations to a greater period at the sending station, and raise them again at the receiving end; and this will be difficult. If we wish to produce light, we have little encouragement in the line of producing an electric wave of the required period by mechanical means. The period of vibration of a charge of electricity, displaced on the surface of a sphere of a centimetre radius, might be a thousand million a second; but to reach the millions of millions necessary for light, the size of the sphere would have to be decreased until it had reached molecular proportions. We have in nature, however, instances of the kind of action we wish. In glow-worms and fire-flies the results we are attempting to attain are reached, and we need not despair of a problem the solution of which is called to our attention on almost any

summer's night. But the line sketched out by Professor Brackett offers, we think, only a very slender hope of accomplishment.

NEW SECONDARY BATTERIES. — Hardly a week passes but we read of some new secondary battery that is to be introduced. This state of affairs has a promising side and an unpromising one. It shows the great need of some reliable storage-battery, and it brings out the fact that a great number of people are working at the problem of finding one. Some of these new cells compare very favorably with the older and better-known types; some of them are, in all probability, not so good. One of the newest is the Johnson battery, which is to be manufactured in Boston. Special advantages are claimed for it, but no figures are given, nor is it anywhere fully described. Two other batteries have been recently put on the market, — the Macreon and the Detroit. We hope to publish some figures as to the latter at an early date: it is a promising type of cell. It is to be hoped that a year which opens with such activity in storage-battery circles will develop some cell that will make electric traction in our crowded cities practicable.

IS A VACUUM AN ELECTRIC CONDUCTOR? — Some time ago M. Foeppl made some interesting experiments on the conductivity of a vacuum; his results tending to show that a vacuum is an insulator, or, at best, its conducting-power is very small. The experiment has been described in this journal. Briefly it consisted in making a galvanometer whose coils were made of glass tubing from which the air had been exhausted, and connecting it with the secondary of an induction-coil, also constructed of glass tubing. There was no inductive effect observed when a current was sent through the primary of the coil, even when the electro-motive force induced had a value of 5,000 volts. M. Foeppl concluded then that an absolute vacuum would be a non-conductor, and that ordinary vacuum-tube phenomena are caused by convection. Some of his more recent experiments tend to throw some doubt on these conclusions. He placed an exhausted tube within a solenoid through which he sent a Leyden jar discharge. Luminous phenomena took place, as in an ordinary vacuum tube provided with electrodes, at which an electro-motive force is applied. We know so little, however, of the nature of luminous discharges in vacua, that we can hardly consider the evidence of the last experiment so strong as that of the first; and while it may be possible to account for either result on the hypothesis of the non-conduction, or on that of the conduction of a vacuum, the former seems much the more probable.

ELECTRIC LIGHT IN THE PATENT OFFICE. — From the report of the secretary of the interior, we learn that arrangements were made the past year with the assistance of Lieut.-Commander Bradford of the United States Navy (among the most expert of electricians), with the Brush Electric Light Company of Cleveland, O., for the construction of the necessary machinery, and the arrangement of wires, appliances, and lamps, for the Patent Office building, in order to light it completely. The department will be able to furnish its own light at so great a diminished cost, that it is believed the saving from the average annual outlay heretofore sustained will in three years reimburse the expenditure for the plant. There are such vast piles of public papers, records, and documents in the various rooms, halls, and cellars of the department, many of these so dark as to require light throughout the day, that a mode of illumination which is consistent with their safety becomes of prime importance. It is believed that this object has been most satisfactorily secured by the arrangements made under the direction of Lieut.-Commander Bradford. Secretary Vilas avails himself of the opportunity to express his sense of obligation for the great advantage enjoyed in the generous contribution of Lieut.-Commander Bradford's expert and valuable knowledge, from which he believes the electrical equipment of the department will hardly be equalled in the country for safety and efficiency, procured upon the most economical terms.

PROFESSOR N. S. SHALER of Harvard University is in Washington, on his way to the Dismal Swamp. He will there spend a fortnight in geographical and geological researches, in order to complete an article for the next annual report of the Geological Survey.

THE OBSERVATORY HILL RAILWAY OF ALLEGHENY CITY, PENN.

THIS railway has been in continuous operation since January, 1888, as an electric road. The line is about four miles in length. For one-fourth of this distance the electric conductors are contained in a sub-surface conduit. For the remainder of the line the conductors are elevated above the roadway, being bracketed off from poles erected along one side of the street. The conduit branches from double to single track, and at the present terminus of the line there is a conduit cross-over switch from down to up track. At different points along the conduit section the conduit cuts through five other street-railway tracks belonging to other companies.

On the elevated conductor section the line is single track with seven turn-outs. Double conductors are used throughout both conduit and elevated conductor sections, neither the rails nor any part of the conduit itself being used as a part of the electric circuit.

Nowhere throughout the whole line is there a space fifty feet long where a car will stand without the brakes being applied. There are thirty-four curves on the line, not including turn-outs or switches. The maximum grade is 12½ feet in 100 feet. There is a total rise of 295 feet in 4,900 feet, with an average of about six per cent. The maximum grade of 12½ is on a reversed curve (radii 100 and 200 feet). The sharpest curve has a 35-foot radius on five-per-cent grade.

The Bentley-Knight conduit system consists of a power station, — engines, boilers, and dynamo-electric machines; a conduit running the whole length of the line, containing the conductors which convey the electric current to the motors; and hanging connections (ploughs) which pass through the conduit slot, and, sliding along the conductors, maintain unbroken connection between the motors and the source of power. The electric conductors are accessible only to regular employees, furnished with special tools, while the current used, even in roads of the heaviest carrying capacity, cannot injure either life or property.

The conduit, which contains the conductors and supplies the current to the motors along the line, can be placed at any point where the opening of the slot will be below any part of the car-body. In constructing a conduit line, the iron yokes shown in the accompanying figure are set up from four to six feet apart, and the conductors set against the insulators which support them at each yoke. The electrical connection between the different lengths of conductor are then made, the slot-steels set on the yokes, and the slot-steels and yokes firmly bolted together, leaving a slot opening at the surface of the street of only five-eighths of an inch. Attention is especially directed to that form of Bentley-Knight conduit which permits the width of the slot to be regulated, the slot rails to be removed, and the conductors, insulators, and interior of the conduit to be inspected, without disturbing the pavement. The conductors are copper bars connected by expansion joints, and are of sufficient size to carry the current with a loss never greater than five per cent. The fact that the conduit can swerve from a straight line to avoid obstructions, and can be laid outside of the track wherever desired, greatly decreases the expense and difficulty of laying.

Electrical connection between the motor and the conductors in the conduit is effected by a contact-plough, which consists of a flat frame, hung from the car by transverse guides (on which it is free to slide the whole width of the car), and extending thence down through the slot of the conduit. It is so constructed as to adjust itself to all inequalities of road or conduit. This frame carries two flat insulated conductor-cores, to the lower ends of which are attached, by spring hinges, small contact-shoes, which slide along in contact with the two conductors in the conduit. At the upper ends are attached connections leading to the motor. This plough can be inserted or withdrawn through the slot at will, the spring hinges allowing the contact-shoes to straighten out into line with the conductor-cores when the plough is pulled upward. By no accident, therefore, can any thing be left behind in the conduit to obstruct succeeding cars. The plough-guides are hung on transverse axes, and are held in a vertical position by a spring-catch that gives way when the plough meets an irremovable obstruction, and allowing the plough to be thrown completely out of the conduit without injury, it being also immediately replaceable. The frame of the